Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia Computer Science 17 (2013) 945 – 950

Procedia Computer Science

Information Technology and Quantitative Management (ITQM2013)

The Research on Credit Risk of Business Groups Based on Related Guarantee

Yang Yang[a], Li Li[b,a], Zhou Zongfang[a,]*

[a]*School of Economics and Management, UESTC, ChenDu,610054,China*
[b]*School of Mathematics, Yunnan Normal University, KunMing 650092, China*

Abstract

The phenomenon of related guarantee is widely exists in the operation of business groups. This related guarantee complicates the credit risk of business groups in one hand and makes the risk control more difficult of commercial banks in the other hand. In this paper it proposed a theoretical model to describe the basic mechanism of credit risk in business groups based on structure model. Then it also analyzed the effect on credit risk of business groups of related guarantee empirically. The research results show that the relationship between amount of guarantee and intensity of credit risk contagion is nonlinear and the different structure of guarantee will bring different influence for credit risk of business groups.

Keywords: Business Groups; Related Gurarntee; Credit Risk; Structure Model; Empirical

1. Introduction

As the important role of business groups in the society and economy, the credit risk management of business groups have an extensive attention by commercial banks. However, the widely related guarantee among the subsidiaries is a significant characteristic for business groups. According to the statistic data by CCER, the proportion of RPT(related-party transaction) for related guarantee has reached to 45.36%. And the related guarantee among subsidiaries in business groups is become the most widely and activity type of guarantee from the perspective of listing corporations based on the statistic data. In one hand, the ownership structure in business groups is very complex. In the other hand, the related guarantee makes the assets correlation more volatile. Both ownership structure and related guarantee make the mechanism of credit risk more difficult in business groups than in the single company. For this reason, many scholars have researched on the credit risk of business groups and how the related guarantee effects credit risk contagion.

Most of the existing researches mainly focused on empirical analysis. Bianco and Nicodano have analyzed the debt relevance of subsidiaries in business groups[1]; Luciano and Nicodano researched the credit risk based on the ownership structure with the method of Leland[2、3]. Only few of the researches have discussed the credit risk contagion of business groups quantitatively. Davis and Lo first proposed the probability model of default contagion[4]. Jarrow and Yu have promoted the simplified model, constructed a basic model to measure the default contagion[5]. Giesecke developed a model describes the effect of credit risk contagion named expand Bernoulli model[6]. Schoenbucher introduced a frailty index model to the area of finance to describe the credit risk which is

* Yang Yang. Tel.: +086-138-8089-0605
E-mail address: fwy0991@yahoo.cn.

doi:10.1016/j.procs.2013.05.120

caused by the information diffusion[7]. Other researches which discussed credit risk of business groups quantitatively mainly focused on two perspectives. One is based on the simplified model developed by Jarrow. And the other is based on the structure model developed by Merton[8]. Besides that, a few of scholars also focused on the problem of integrated risk with different related risks quantitatively[9,10]. But all these researches above did not focus on the effect on credit risk of business groups of related guarantee.

Besides the first section, this paper proposed a mathematic model based on structure model to analyze the credit risk contagion between two subsidiaries in section two. And in the section three we discuss the affect for credit risk of business groups with different type of related guarantee based on the empirical data. The last section is the conclusions of this research.

2. The Basic Mechanism of Risk Contagion Based on Related Guarantee

The section two can be divided into two parts. The first part of this section is the mathematic model which can describes the mechanism of risk contagion. And the second part of this section is the main result of the theoretical model.

2.1 Mathematic Model

It assumes that a business group is constructed by two subsidiaries: subsidiary *A* and subsidiary *B*. The subsidiary *A* has borrowed *K* from commercial bank at *t=0*. The mature time of these loan is *t=T*. For simplicity, it further supposes that the subsidiary *B* has provided related guarantee for subsidiary *A*. The guarantee contract promises that the related guarantee has priority right while subsidiary *A* defaults.

Follow the assumption of previous research[11], it assumes that subsidiary B has debt $X_B(X_B>0)$, mature time of its loan is *T*. For simplicity, subsidiary *A* has not any other debt during the time [*o,T*]. To describe the relationship between subsidiary *A* and subsidiary *B* in business group, it supposes subsidiary *B* has λ stake in subsidiary *A*. In order to take advantage of structure model, it assumes values of subsidiary *A* and subsidiary *B* at time *t* are $V_A(t)$ and $V_B(t)$. The value of subsidiary *B*, $V_B(t)$, can be divided into two parts. First part is the value of held equity of subsidiary A. i.e. $\lambda V_A(t)$. The other part of is the rest part of value of subsidiary *B* which is shown as *Y(t)*.

$$\lambda V_A(t) + Y(t) = V_B(t) \tag{1}$$

Further, it supposes that the values of these two subsidiaries are subject to the following random process:

$$\begin{cases} \dfrac{dV_A(t)}{V_A(t)} = \mu_1 dt + \sigma_1 dW_t^1 \\ \dfrac{dV_B(t)}{V_B(t)} = \mu_2 dt + \sigma_2 dW_t^2 \end{cases} \tag{2}$$

In which μ_1 and μ_2 is the drift parameters describe the expected return yield of value. σ_1 and σ_2 represent the standard deviation of the value of subsidiary *A* and subsidiary *B*. (W^1, W^2) is the noise terms represents random fluctuation of value. And the correlation coefficient ρ represents the value fluctuation dependency.

Assuming $(W_{t_1}^1, W_{t_2}^2) \sim N(0, \Sigma)$, where $\Sigma = \begin{bmatrix} t_1 & \rho\sqrt{t_1 t_2} \\ \rho\sqrt{t_1 t_2} & t_2 \end{bmatrix}$. According to Ito lemma, the value of subsidiary *A* and subsidiary *B* at *T* is as follow.

$$V_A(T) = V_A(0)\exp\{m_1 T + \sigma_1 W_T^1\} \tag{3}$$

$$V_B(T) = V_B(0)\exp\{m_2 T + \sigma_2 W_T^2\} \tag{4}$$

In which $m_i = \mu_i - \sigma_i^2/2$, $V_A(0) > 0$, $V_B(0) > 0$, $i = 1,2$, so

$$Y(T) = V_B(T) - \lambda V_A(T) = V_B(0)e^{m_2T+\sigma_2W_T^2} - \lambda V_A(0)e^{m_1T+\sigma_1W_T^1} \quad (5)$$

Suppose $K = \alpha V_B(0) = \beta V_A(0)$, so $\frac{V_A(0)}{V_B(0)} = \frac{\alpha}{\beta}$

If the value of subsidiary *A* has $V_A(T)<K$ at time *T*, the subsidiary *A* will face to bankrupt.

Denote the binomial random variable Z_A as the default affair of subsidiary *B*. The value space of Z_A is [0,1]. Z_A=1 denotes the default affair and Z_A=0 denotes not default affair.

Meanwhile if the value of subsidiary *B* cannot afford its debt or guarantee, the subsidiary *B* will face to bankrupt.

Also denote the binomial random variable Z_A as the default affair of subsidiary *B*. Z_B=1 denotes the default affair and Z_B=0 denotes not default affair.

It measures the intensity of credit risk contagion with the condition default probability $\Pr(Z_B = 1 | Z_A = 1)$

It can be easily noticed that if the subsidiary *A* default, the value of subsidiary *B* will decrease to *Y(T)*. According to the structure model of Merton, it can get:

$$\Pr(Z_B = 1 | Z_A = 1) = \Pr(Y(T) < K - V_A(T) + X_B | V_A(T) < K) \quad (6)$$

Formula (3)-(5) into formula (6), it can get

$$\begin{aligned} &\Pr(Z_B = 1 | Z_A = 1) = \Pr\{V_B(T) - \lambda V_A(T) < K - V_A(T) + X_B | V_A(T) < K\} \\ &= \Pr\left\{V_B(0)e^{m_2T+\sigma_2W_T^2} + (1-\lambda)V_A(0)e^{m_1T+\sigma_1W_T^1} < K + X_B \middle| V_A(0)e^{m_1T+\sigma_1W_T^1} < K\right\} \quad (7) \\ &= \Pr\left\{e^{m_2T+\sigma_2W_T^2} + (1-\lambda)\frac{\alpha}{\beta}e^{m_1T+\sigma_1W_T^1} < \alpha + \frac{X_B}{V_B(0)} \middle| e^{m_1T+\sigma_1W_T^1} < \beta\right\} = G(\lambda,\alpha) \end{aligned}$$

Because the $\frac{V_A(0)}{V_B(0)}$ is a constant, so the value for guarantee by subsidiary B can be determined by α and β. So there only one of the two parameters is independent. Suppose this independent parameter is α.

2.2 Model Analysis

By the formula (7) above, it can be easily known that the intensity of credit risk contagion is a monotonically increasing function for subsidiary *A*'s stake which is held by subsidiary *B*.As the measurement of intensity of credit risk contagion is constructed by two random processes, it uses the numerical method to analyze the relationship of related guarantee and intensity of credit risk contagion. The figure 1 below shows intensity of credit risk contagion with the change of amount of related guarantee.

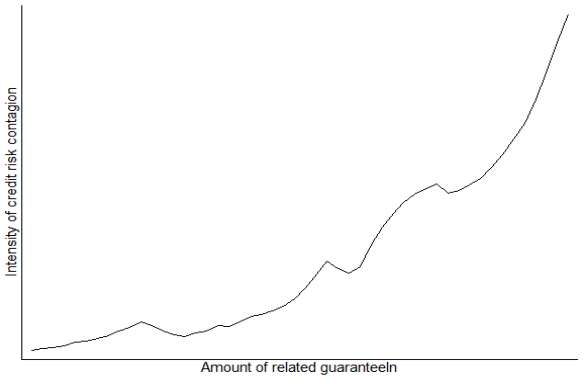

Figure 1 Relationship between intensity of credit risk contagion and amount of related guarantee.

Figure 1 illustrates that the intensity of credit risk contagion of business group is increase with the increasing of amount of related guarantee. But the relationship between intensity of credit risk contagion and amount of related guarantee is nonlinear. This may explain some different characteristics for different business groups by the different parameters of the assumption in random processes. Also as the amount of related guarantee is large enough, the intensity function about related guarantee is convex. This illustrates that when the related guarantee is large enough, the increase of intensity of credit risk contagion is faster than the increase of the amount of related guarantee.

3. Affect on Credit Risk of Business Groups with Different Guarantee

This section it discussed the problem that how does the related guarantee effect the credit risk of business groups based on empirical data. In the first part of this section, it will introduce the empirical data and basic statistic method to analyze. And in the second part of this section, it will show the main results of this empirical research.

3.1 Data and Method

From the section 2, it can be known the basic mechanism of credit risk contagion in business group by related guarantee. A further question is naturally brought out. That is how related guarantee effect to the integral credit risk of business group. If the related guarantee has different affect in different situation. For this, in this section, it selects 100 Chinese listed companies as the research samples during the year 2005 to the year 2010. The data is selected from CCER database.

To avoid the inconsistent of different business groups, this paper standardizes all indicators and make the value of all indicators in the internal [0,1]. To describe the difference of related guarantee, it classifies the business groups with two perspectives. One perspective is focus on the form of business groups. In this way the business groups can be classified into two types. One type is vertical integration and the other type is diversification. The second perspective is focus on the nature of business groups. In this way the business groups can be classified into three types. The first type of business group is state owned. The second type of business groups is private owned. And the last type is others. It uses the situational variables to describe the difference business groups (different related guarantee).

Also follows the previous research, it chooses some financial indicators as the control variables of our research. These control indicators are listed as table1.

Table 1 Control variables

Control Variable	Explanation
X_1: current ratio	current asset / current debt
X_2: quick ratio	liquid asset / current debt
X_3: asset-liability ratio	total debt / total asset
X_4: return on asset	(total profit + financial cost) / average total asset
X_5: net profit rate	net profit / total asset
X_6: operating margin	operating profit / (main income + other income)
X_7: earnings per share	net profit / total shares
X_8: inventory turnover	sale cost / average balance of inventories
X_9: asset turnover	main income / total asset
X_{10}: net cash sales	cash of sale / income of sale

3.2 Empirical Analysis

It uses the basic .econometric method i.e. Logistic to the empirical analyze. Because of the accessibility of data, it's hard to judge the level of credit of a business group. For this reason, it follows the basic idea of structure model that it can use the value of total stakes which have already standardized to measure the credit level. In order to make the result significant, it selects the threshold of standardized value of total stakes as 0.7.

Then table 2 shows the result of regress with the perspective of different types of business groups.

Table 2 Result of regress in different type of business groups

Types	Parameter Estimation	Standard Deviation	Significance Level
Vertical Integration	-1.0022	0.531	0.0243
Diversification	0.0635	0.351	0.0102

Table 2 above has shown that the related guarantee has significant effect to integral credit risk of business groups no matter the type of the business is vertical integration or diversification. But it worth to mention that the related guarantee in vertical integration business groups and diversification business groups has the inconsistent affect to integral credit risk of business groups. From the parameter estimation in table 2 can be easily get the result that the related guarantee has positive influence to increase the integral credit risk in diversification business groups and it has negative influence to increase the integral credit risk in vertical integration business groups.

This result may partly explain the phenomenon that in vertical integration business groups, related guarantee is often used to increase the value chain in the business groups and in diversification business groups, related guarantee is often used to manipulate internal capital market to achieve the private aim which will decrease the integral value of business groups.

Table 3 shows the result of regress with the perspective of different nature of business groups.

Table 3 Result of regress in different nature of business groups

Types	Parameter Estimation	Standard Deviation	Significance Level
State Owned	0.1364	0.322	0.1353
Private Owned	0.0453	0.743	0.0286
Other	0.1024	0.589	0.0648

From table 3, it can be easily know that totally the related guarantee will increase the integral credit risk of business groups no matter what nature the business group is. Also from the standard deviation in table 3, the standard deviation of private owned business groups is larger than the other two kind of business groups. This may explained the diversification of private owned enterprise.

Although the affect on integral credit risk of related guarantee is consistent in different nature of business groups, the significance level in different nature is very different. The private owned business groups are significant in the confidence level of 5% and the state owned business groups are significant in the confidence level of 15%. This result illustrates that the aims of related guarantee in state owned business groups may different from the aims in private owned business groups on one hand. And on the other hand, it also provides some helpful suggestion to commercial banks for its risk management.

4. Conclusions

Business groups are very important for both commercial banks and government. In this paper, we first constructed a mathematic model to analyze the basic mechanism of credit risk contagion by related guarantee based on the structure model. Then we used the empirical data to discuss the problem that if the related guarantee has the same affect on integral credit risk of business groups with different situation. In order to distinguish the different situation, we have classified the business groups with two perspectives. One perspective is the types of business groups and the other perspective is the nature of business groups. At last we can get three main conclusions from this paper as below. First the intensity of credit risk contagion is increase with the amount of related guarantee totally. But the relationship between the intensity of credit risk contagion and amount of related guarantee is nonlinear. Second the effect to the integral credit risk of business groups of both vertical integration and diversification is significant. But the affect in vertical integration business groups and in diversification business

groups is inconsistent. Third the affect on integral credit risk of business groups of related guarantee in consistent with all natures. But the significance level in different nature is not the same.

All these conclusions have some reference value for the future research on related guarantee and credit risk of business groups on one hand. And on the other hand they also provides some helpful suggestion to commercial banks for its credit risk management.

Acknowledgements

This research has been supported by National Natural Science Foundation of China (70971015, 71271043), the Special Research Foundation of PhD Program of China（20110185110021）

References

1. Bianco M., Nicodano G. Pyramdial groups and debt[J]. European Economic Review, 2006,50(4):937-961.
2. Luciano E., Nicodano G. Ownership links, leverage and credit risk[R]. International Financial Research Forum. Pairs, 2008.
3. Leland H. E. Financial synergies and the optimal scope of the firm: implications for mergers spinoffs and structured finance[J]. Journal of Finance, 2007,62(2):765-807.
4. Davis M., Lo V. Infecious defaults[J]. Quantiative Finance, 2001,1:382-387.
5. R. Jarrow, F. Yu. Counterparty risk and the pricing of defautable securitity[J]. Journal of Finance, 2011,56(5): 176-1799.
6.Giesecke K., Stefan Weber. Cyclical correlation, credit contagion, and portfolio losses[J]. Journal of Banking and Finance, 2004,28:3009-3036.
7. Schoebucher P. J. Information driven default contagion[J]. Working Paper ETH. 2003.
8. Merton R. On the pricing of corporate debt: the risk strucutre of intrest rates[J]. Journal of Finance, 1974,29(2):449-470.
9. Jianping Li, Jichuang Feng, Minglu Li. Risk integration mechanisims and approaches in banking industry[J]. International Journal of Information Technology and Decision Making, 2012,11(6):1183-1213.
10. Jianping Li, Minglu Li, Hao Song, Dengsheng Wu. An integrated risk meaurement and optimization model for trustworthy software process management[J]. Information Science, 2012,191:47-60.
11. Chen L, Zhou ZF, Gu J. Evaluation credit risk of an enterprise group's parent company in view of compound option basket option and ownerships[J]. Chinese Journal of Management Science, 2011,5(19): 167-172.